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Psychological Effects of Military Combat

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Until the 20th century, chronicling the psychological effects of exposure to war on soldiers was the domain of poets such as Homer (*The Iliad, The Odyssey*), playwrights such as Shakespeare (*Henry IV*), and novelists such as Stephen Crane (*The Red Badge of Courage*). Beginning with Freud and continuing into the early part of this century, the psychological and physiological effects of war were seen as sequelae of exposure to massive deprivation and rigorous physical conditions as well as explosives (e.g., the term "shell shock" was used to describe a psychological condition that was thought to have developed as a function of proximity to explosions). This work clearly placed the psychological effects of war in the medical arena, and both neurologists and psychiatrists began to study more closely the effects of exposure to overwhelming and life-threatening stressors (see Weathers et al., 1995).

During World War II, consistent descriptions of the effects of military experiences on soldiers began to emerge. Classic texts by Kardiner (1947) and Grinker and Spiegel (1945) provided compelling descriptions of the phenomenology, nosology, assessment, and treatment of war-related stress disorders. These works clearly set the stage for contemporary research on post-traumatic

stress disorder (PTSD) in general, and on combat stress disorders specifically. In the 1970s, as a function of the Vietnam war, a series of scientific studies addressed the effects of this war on U.S. soldiers. Although clearly a distinctive war from a sociopolitical perspective, the scope and the nature of the Vietnam war's psychological aftereffects shared many characteristics with those of other wars. Veterans reported a wide range of disabling psychological problems that included anxiety and depression, nightmares, sleep disturbance, dissociative-like flashback experiences, and psychophysiological reactivity to cues of traumatic events (Figley, 1978; Wilson, 1978). This psychophysiological reactivity was seen by some researchers as central to PTSD and its adverse psychosocial consequences.

This chapter presents information from two key studies that contribute to our understanding of the effects of exposure to combat. The first is the National Vietnam Veterans Readjustment Study (NVVRS), a major epidemiological effort to estimate the prevalence of PTSD in the Vietnam veteran population. The second is a multisite study of the psychophysiological parameters of PTSD and the extent to which psychophysiological reactivity, long viewed as a major feature of PTSD, was indeed a fundamental

component that could be reliably observed in laboratory settings. This is known as the PTSD in Vietnam Veterans (PIVVET) study.

NATIONAL VIETNAM VETERANS READJUSTMENT STUDY

In addition to the psychological and psychophysiological symptoms reported by Vietnam veterans in earlier studies, data indicated that the war had profound social, marital, and interpersonal effects on its participants. Interestingly, other studies conducted concurrently concluded that the adverse effects of exposure to war were a function of pre-existing psychopathology, substance abuse, behavioral problems, and other known risk factors that predisposed these individuals to develop combat-related disorders (Helzer, 1984; Helzer et al., 1987; Worthington, 1977). These studies placed greater emphasis on these pre-existing characteristics than on levels of combat exposure in the ultimate development of psychopathology.

All these studies suffered from serious, and perhaps even fatal, methodological flaws influencing the validity of conclusions drawn from them. Their primary value was in alerting society to the large number of individuals who served in Vietnam who were having adjustment problems, and to the fact that many people sent to Vietnam possessed characteristics that placed them at some risk for the development of disorder when exposed to stress. None of the studies could accurately inform the public about the number of veterans with psychological problems or the variables that would predict disorder or adjustment. For example, virtually all of the studies conducted in the 1970s and early 1980s suffered from difficulties in sampling. No study included a representative sample of veterans who had served in the war, and most samples either were drawn by convenience or were clinical samples of patients seeking services at different institutions. Some samples of veterans were so small that it was impossible for them to yield reliable findings of the current status of Vietnam

veterans (Helzer et al., 1987). Moreover, the typical study either did not measure PTSD at all or did so using instruments that had questionable reliability and validity. Because of these limitations, it was virtually impossible to comprehensively understand the psychological and social effects of service in Vietnam. What we needed was a study that would permit policy makers to understand as specifically as possible the psychological effects of exposure to combat in Vietnam. Such a study would serve to elucidate the psychosocial problems of Vietnam veterans and guide policy makers in constructing a social policy that would be optimally beneficial to veterans and their families.

To accomplish this, in 1984 the U.S. Congress mandated an epidemiological study of the psychological and social effects of the Vietnam War on its veterans. This study was to address many of the methodological and measurement flaws noted in previous studies and provide information to resolve some of the discrepancies in the scientific literature regarding the long-term effects of the war on its participants. To this end, a study designed to measure premilitary, military, and postmilitary factors to determine the contribution of each to the overall functioning of Vietnam veterans was proposed.

The NVVRS was funded by the U.S. Department of Veterans Affairs (DVA) and conducted under contract with the Research Triangle Institute (RTI) of North Carolina. The study (Kulka et al., 1988) had three primary objectives: (1) to determine the prevalence of PTSD and other psychological disorders that might have occurred as a result of participation in the Vietnam War; (2) to examine the current life adjustment of individuals who participated in the war; and (3) to study factors related to the development of PTSD.

The design of this research study incorporated a number of significant features that would permit conclusions to be drawn regarding the extent to which any problems found would be specific to service in the Vietnam war zone. The design featured the following three comparison groups: (1) a representative sample of Vietnam-theater

veterans, (2) a sample of Vietnam-era veterans who did not serve directly in the war zone but who did serve in the military during the same time period, and (3) a civilian sample that was comparable on variables such as age, sex, race, and education. In drawing the Vietnam-theater veteran sample, all U.S. veterans from 1964 to 1975 who served in the Vietnam theater or in the airspace above or the seas surrounding the theater had known probabilities of being included in the study. In addition, the sampling strategy employed in this project oversampled certain subgroups of the population in order to draw conclusions specifically about each group. The groups oversampled were (1) African-Americans, (2) Hispanic-Americans, (3) women, and (4) those who received physical injuries as a result of the war.

Pretest Validation Study

At the time the NVVRS was initiated, few measures of PTSD possessed acceptable psychometric properties. Given the scope and the importance of this project for public policy, there was considerable interest in ensuring that any measures used had demonstrated reliability and validity, as well as acceptable levels of sensitivity and specificity. To assure the use of appropriate measures, the RTI research group conducted a pretest validational study examining the performance of numerous candidate measures.

In this pretest validational study, multiple sites using very experienced clinicians examined more than 200 veteran patients with known diagnoses (some with PTSD, some without PTSD, and some with disorders other than PTSD). From this pretest validational study, several measures of PTSD were selected, including a PTSD module of the Diagnostic Interview Schedule (Robins et al., 1981) to be used by lay interviewers in conducting the survey portion of the study; the Mississippi Scale for Combat-Related PTSD, a self-report measure for combat-related PTSD and related symptomatology (Keane et al., 1988a); and the Structured Clinical Interview for *DSM-III-R* (SCID) PTSD module to be used by clinicians in a second stage of the study when examining a portion of the sample derived from the initial screening by lay interviewers. At this second stage the Keane PTSD (PK) Scale of the Minnesota Multiphasic Personality Inventory–2 (MMPI-2) (Keane et al., 1984) and the Stress Response Rating Scale (Weiss et al., 1984) were also employed in the context of examining the "clinical subsample."

The procedures designed for use in this study stem from Dohrenwend's two-stage approach to assessment of psychopathology in field settings (Dohrenwend & Shrout, 1981). Stage one included a survey conducted by lay interviewers who were well trained in the administration of the specific assessment instruments to be used. The second stage of this design included a clinician's assessment conducted by clinical psychologists, psychiatrists, and doctoral-level nurses and social workers. The clinician's assessment was reserved for all cases deemed positive on the lay survey (Mississippi Scale score $\geq$ 89), but also included all cases that were seen as high risk for disorder (e.g., high combat exposure) and a randomly selected subsample of all negative cases. This two-stage strategy permitted an examination of the reliability and accuracy of the lay survey case identification; it also provided the opportunity to adjust information about cases on the basis of this additional, clinically derived information. Ultimately, the strategy employed by the researchers in this study was to assign a probability of PTSD "caseness" depending upon variables collected in the lay interview adjusted by information collected in the clinician's assessment.

Results of the NVVRS

Findings from the NVVRS indicated that, among male Vietnam-theater veterans, current rates of PTSD were 15.2% compared with 2.5% among Vietnam-era veterans and 1.2% among the civilians. These differences between the Vietnam-theater veterans and the two comparison groups reached statis-

tical significance. In terms of lifetime prevalence of PTSD among male theater veterans, a prevalence rate of 30.9% was observed. Using an estimate of 3.14 million American people having served in Vietnam, the study projected approximately 479,000 cases of current combat-related PTSD in the Vietnam-theater sample. In addition, approximately twice that number had PTSD at one time or another since their return from the war.

Among women, the prevalence rate of current PTSD for the Vietnam-theater veterans was 8.5% compared to 1.1% for Vietnam-era veterans and 0.3% for the matched civilian comparisons. The majority of women who served in Vietnam were nurses; consequently, the matched civilian comparison group was not representative of the general population. Lifetime prevalence rates of PTSD among the Vietnam-theater veteran women were 26.9%.

The NVVRS also found notable differences in current prevalence of PTSD among racial and ethnic subgroups. Among the white/other veterans, there was a prevalence rate of 13.7% for current PTSD. Among African-American veterans, there was a prevalence of 20.6% of current PTSD, and among Hispanic-American veterans, the prevalence of current PTSD was 27.8%. These differences were striking in terms of the magnitude of differential effects of the war and also for their policy implications. Subsequent analyses of these findings revealed that, controlling for levels of combat and war-zone stress exposure, the differences between African-Americans and whites were no longer statistically significant, while the differences between Hispanic-Americans and these two groups remained statistically significant, although at a substantially reduced level. These findings indicated that resulting differences in prevalence rates were largely a function of differences in reported levels of combat and war-zone stress exposure: this was particularly true for the African-American cohort.

Data in this study were also analyzed by examining differences in current PTSD rates among those exposed to high rates of war-zone stress. Among male veterans, those exposed to low or moderate stress during the course of their service had a prevalence rate of PTSD of 8.5%; those exposed to high amounts of war-zone stress had a current prevalence rate of 35.8%. Similarly, women veterans who were exposed to low or moderate war-zone stress during their service in Vietnam had a current prevalence rate of 2.5%, whereas those exposed to high war-zone stress had a current prevalence rate of 17.5%. (In interpreting these results, it is essential to know that war-zone stress was defined differently for men and women because of the different roles in which men and women served during the Vietnam War.)

Importantly, the high rates of PTSD among the Vietnam-theater veteran subjects still exceeded the rates of this disorder in the comparison groups even when numerous predisposing risk factors or personal characteristics were controlled statistically. Specifically, a wide range of demographic variables (including age, sex, race, and education), socioeconomic status variables, quantitative measures of the subject's childhood and adolescent social environment, the presence of delinquent or antisocial behavior, the presence of psychological and psychiatric disorders, and a wide range of biopsychosocial factors previously found to be related to the development of psychopathology were examined. Even with all of these variables controlled statistically, there were still differences between the Vietnam-theater veterans and both Vietnam-era veterans and civilian controls in terms of prevalence of current PTSD. These findings strongly indicate that the source of the difference in current psychological problems among the Vietnam-theater veteran group and the other comparison groups was service in the war zone. Furthermore, the strong relationship between war-zone stress exposure variables and PTSD pointed to specific experiences (i.e., life threat from traumatic events) that occurred in Vietnam as the pathogenic variables leading to disorder. Studies examining the nature of

PTSD using the NVVRS data confirm these factors as important variables (e.g., King et al., 1995), thus further contributing to the knowledge base on the issue of causation.

What does it mean to have PTSD? An examination of the many psychosocial variables measured in this study provided important insights to factors associated with PTSD. Individuals who have PTSD or who have ever had it seem more likely to develop at least one other psychological disorder during the course of their lives. Typically, this is a substance abuse or depressive disorder. One-half of individuals with PTSD currently have another psychological disorder. Moreover, PTSD veterans were 5 times more likely to be unemployed at the time of the survey than theater veterans without PTSD. Seventy percent of PTSD veterans have been divorced; 35% have been divorced two or more times. Fifty percent reported high levels of marital problems and 55% reported high levels of parenting problems associated with their children. Twenty-five percent of Vietnam-theater veterans with PTSD report being very dissatisfied with their lives.

Other important social variables were also associated with a diagnosis of PTSD. Forty-seven percent of PTSD veterans reported being isolated; 35% reported being homeless at one time since their separation from the military. Moreover, 37% of PTSD veterans reported being involved in six or more acts of violence in the past year, with a mean of 13.3 acts of aggression. Relatedly, 50% of PTSD veterans reported being arrested or jailed once, and 34% reported being arrested or jailed more than once. Among these individuals, 12% were arrested for a felony. In addition, 40% of PTSD veterans scored highest on ratings of hostility, anger, and aggression. For all of these problems, the rates among PTSD veterans were at least twice those of Vietnam-theater veterans without PTSD.

In conclusion, the prevalence of PTSD among Vietnam-theater veterans appeared to be high for lifetime and current rates of disorder. These high rates of disorder were accompanied by a wide range of psycholog-ical and social problems that place these individuals at great risk in contemporary society. In addition, the problems observed in the NVVRS appeared to be a function of war-zone stress exposure, rather than of pre-existing conditions or circumstances that led individuals into the military or into Vietnam specifically. The problem of PTSD among Vietnam-theater veterans is significant to public health in the United States. With 3.14 million veterans of Vietnam, plus their spouses and children, many of whom have related psychological and social problems, this disorder represents a major concern for the United States in terms of delivery of appropriate social and mental health services.

As the first comprehensive study conducted by any nation to examine the psychosocial consequences for soldiers of participating in a war, the NVVRS demonstrated convincingly that the environment to which we expose military personnel in war and peacekeeping efforts can place them at considerable risk for the development of longstanding, serious, and in some cases debilitating psychological problems. These findings may be useful in identifying who is at greatest risk for the development of psychological disorders as well as for encouraging the development of programs and procedures that may prevent disorder among combatants. In particular, efforts to train soldiers in a variety of adaptive and self-help skills prior to exposure to massive stressors may prove to be a worthwhile enterprise. Second, providing the opportunity for psychological debriefing following exposure to massive stressors may also prevent development of untoward expectations, provide an opportunity to normalize an individual's psychological reactions, and provide requisite social support to assist people in their own psychological recovery from this exposure. Identifying methods for implementing these interventions are matters for further research. The remainder of this chapter is devoted to a description of some of the main work underway to expand knowledge about the nature of PTSD— knowledge on which preventative and remedial efforts must be based.

PSYCHOPATHOLOGY AND PSYCHOPHYSIOLOGY OF CHRONIC PTSD

Problems of Vietnam veterans, particularly PTSD, have been major concerns of the DVA and the Department of Defense for an extended time. The DVA has been especially interested in the development of contemporary methods for assessing PTSD in order to assist clinicians in the provision of appropriate treatment and to assist adjudicators in determining disability compensation claims. In addition to issues of psychological assessment, studies of the psychopathology associated with the disorder are lacking and are sorely needed. The diagnostic criteria and description of PTSD contained in the *Diagnostic and Statistic Manual of Mental Disorders* (third edition, revised) (*DSM-III-R*) of the American Psychiatric Association (1987) derive from numerous clinical studies of veterans and the observations of clinicians who work with them. Further work on the phenomenology of PTSD is warranted.

Psychophysiological reactivity in PTSD has been observed clinically for many years. Kardiner (1941), in his studies of World War I veterans, referred to the disorder as a "physio-neurosis" because of the many somatic complaints and problems he noted among war veterans. Gillespie's (1942) study of veterans' complaints also specified generalized muscle tension, including headache and backache, as well as heart palpitations and panic reactions, as central features of the disorder. Also noticing this same pattern of psychophysiological reactions among trauma-exposed veterans were Grinker and Spiegel (1945), who observed excessive muscle tension, startle reactions, and a wide range of psychophysiological and psychosomatic symptoms among combatants.

One question that arose from these observations was the extent to which the psychophysiological reactions that were apparent among war trauma survivors were predominantly tonic phenomena as well as phasic reactions. A second and related issue was the extent to which the phasic reactions occurred specifically in response to trauma-related cues or, rather, were a more generalized reaction to any stimulation. Evidence supporting the trauma specificity of the physiological reactions would provide support for the role of the traumatic events in the development of the disorder.

The early observations by clinicians led to a number of experimental studies that examined psychophysiological parameters among combat veterans. Wenger (1948) examined three groups of subjects: (1) 225 subjects with "operational fatigue," (2) 98 subjects with neurotic disorder, and (3) 448 subjects who were normal Air Force students. This comparative study measured baseline differences in psychophysiological functioning. Wenger found differences in the operational fatigue group (predecessor of PTSD) when compared to the neurotics and the Air Force students on the following measures: salivary output, systolic and diastolic blood pressure, heart rate, respiration rate, palmar conductance, sinus arrhythmia, finger temperature, and mean tidal air values. In all cases the operational fatigue subjects demonstrated higher levels of arousal than did either of the two comparison groups. This study did not involve any experimental manipulation, nor did it involve exposure to neutral or relevant stressors, but it did demonstrate clearly that, even at baseline, subjects with war stress–related problems performed differently on psychophysiological variables than did comparison groups of subjects.

Dobbs and Wilson (1960) examined 8 decompensated veterans (probable PTSD) and compared them to 13 compensated combat veterans and 10 nonveteran student controls. This study presented combat cues, including flashing lights and sounds of weapons firing, to the participants. At baseline, the researchers found that the decompensated veterans had higher heart rates than did either of the two comparison groups. Perhaps more striking was their inability to measure any psychophysiological variables during the presentation of combat cues because of the high levels of arousal exhibited by the decompensated veterans and their in-

ability to remain in the experimental situation.

Using more contemporary methods for psychophysiological measurement and cue presentation, Blanchard et al. (1982) examined 11 Vietnam veterans with a diagnosis of PTSD and compared them with nonveteran normal controls. They presented auditory combat cues, alternating with neutral cues, while measuring heart rate, blood pressure, electromyogram (EMG), and skin conductance. Psychophysiological reactivity, and in particular elevation in heart rate, was demonstrably different among the PTSD veterans. Using simply heart rate reactivity, this study correctly classified 95.5% of the subjects in either the PTSD or the no-PTSD groups. The sole subject who was incorrectly classified was a PTSD subject taking a major tranquilizer.

Malloy et al. (1983) examined a group of PTSD veterans and compared them with two distinct groups, veterans with psychiatric diagnoses and well-adjusted combat veterans. Using visual and auditory cues of combat, these researchers measured heart rate and skin conductance as well as subjective measures of distress. Employing all measures of arousal (physiological and subjective), they were able to successfully classify 100% of the subjects of the study into PTSD and no-PTSD groups. Relying exclusively on the physiological measures, the correct classification rate of PTSD and no-PTSD subjects was 80%.

Utilizing the experimental model for the study of emotion developed by Lang (1977), Pitman et al. (1987) examined psychophysiological reactivity in 15 PTSD veterans and 18 combat veteran controls. They employed combat and noncombat imagery that contained relevant traumatic and nontraumatic life experiences for each of the subjects. Measures of heart rate, skin conductance, and EMG led to 100% correct classification of PTSD subjects and 61% classification of no-PTSD subjects in this study (i.e., high sensitivity and moderate specificity).

These contemporary studies of psychophysiological reactivity to combat cues resulted in impressive overall classification rates with particularly strong sensitivity and good specificity. These studies occurred in three separate research laboratories over approximately 6 years. Replications of these findings within these same laboratories and in additional laboratories led to concrete evidence that veterans with PTSD suffered from strong physiological reactions to relevant cues, and that this reactivity might be helpful in our understanding of the disorder and in the development of non-self-report assessment methods. Baseline differences in physiological measures appeared in some studies but not in all, leaving open the possibility that veterans with PTSD might suffer from both tonic and phasic physiological arousal problems.

Despite the strengths of these cross-laboratory findings, however, numerous methodological problems limited the extent to which firm conclusions could be drawn regarding the utility of psychophysiological reactivity in assessing PTSD. These limitations included (1) the small sample sizes contained in virtually all of the studies conducted, (2) PTSD base rates in the studies that exceeded expected base rates of PTSD in the help-seeking population, (3) the inclusion of non-treatment-seeking controls, (4) the absence of any cross-validation information on the classification rates, (5) limited test–retest reliability particularly among the physiological variables, and (6) the absence of a complete utility analysis (i.e., sensitivity rates, specificity rates, predictive power of a positive test, and predictive power of a negative test). The presence of these limitations led to the development of a multisite clinical trial that could address the question of whether physiological parameters could be useful in the diagnosis and classification of patients with PTSD; this trial would contain sufficient subjects and power to address this question in a thorough manner.

THE PIVVET COOPERATIVE STUDY

Funded by the DVA Cooperative Study Program, the PIVVET study attempted to ad-

dress each of the methodological limitations identified in the psychophysiological literature to date. It had as its objective the development of a physiological indicator for the presence of PTSD when compared to a comprehensive examination and diagnosis by a trained clinical psychologist.

This study employed as subjects male Vietnam-theater veterans who enrolled in the study via a consecutive cohort admission procedure across the various sites involved. All subjects were drug and alcohol free at the time of the research, and urinalyses confirmed the absence of illicit drugs in subjects included in the analyses. Exclusion criteria for the study included the presence of cardiovascular disease, organic mental disease, and any of the spectrum psychotic disorders. The primary hypothesis was that variables from the psychophysiological protocol would predict the clinicians' diagnosis of PTSD obtained from the SCID PTSD module.

Methods

Subjects

Included in this study were 1240 male Vietnam veterans recruited from 15 Veterans Affairs (VA) Medical Centers across the United States. All subjects were seeking services and were therefore comparable in nature to VA patients for whom the diagnostic test was intended (Kraemer, 1992).

Subjects in the study averaged 41 years of age. Among those diagnosed with PTSD, there was a mean of 13.6 years of education; for those without PTSD, the average education was 14.6 years. Annual income for the PTSD subjects was $12,560; for those with no PTSD annual income was $25,270. Percent disability for the PTSD group was 31; for the no-PTSD group, it was 21.7. The number of jobs per subject in the PTSD group was 27.6; for the no-PTSD group the mean was 11.5.

In the PTSD group 8.3% had at least one criminal arrest since discharge, compared with 2.6% in the no-PTSD group. With respect to marital histories, 40.8% of the

Table 3.1. Psychometric data on PIVVET participants

	PTSD	No-PTSD
Combat Exposure Scale score	28.8 (high)	17.9 (moderate)
Vietnam trauma (yes)	99%	81.4%
Mississippi Scale score (mean)	123.0	78.1
MMPI PK scale (mean)	30.4	13.9

PTSD group had been married more than once; among the no-PTSD group, 26.6% had been married more than once. PTSD subjects reported an average of 5.0 hours of sleep per night, while the no-PTSD subjects averaged 6.5 hours per night. Table 3.1 presents psychometric data for participants.

Diagnostic Co-morbidity

For subjects who met diagnostic criteria for PTSD, 24.6% reached criteria for a current diagnosis of alcohol abuse, compared to 13.9% of those without PTSD. Fourteen percent of PTSD subjects met criteria for drug abuse, while only 6.3% of those without PTSD met these criteria. Similarly, subjects with PTSD met criteria for panic disorder more frequently, with 13.4% in the PTSD group reaching criteria and none without PTSD receiving this diagnosis. Major depression, a frequently co-occurring diagnosis with PTSD, was found in 34.5% of the PTSD subjects, while only 5.9% of those without PTSD met criteria for a current diagnosis of major depressive disorder.

With regard to *DSM-III-R* Axis II disorders, 18% of PTSD subjects also met criteria for borderline personality disorder, compared to only 3.4% without PTSD. The figures for antisocial personality disorder were 10.6% for those with PTSD and 3.0% for those without PTSD.

Assessment Measures

Clinicians employed the SCID (Spitzer & Williams, 1985) to examine patients for the

Table 3.2. Psychophysiological assessment protocol

Condition	Length of presentation (min)
Baseline 1	10
Mental arithmetic	1–2
Baseline 2	5
Neutral slides	9.5
Baseline 3	5
Combat slides	7
Baseline 4	5
Neutral script 1	2
Combat script 1	2
Neutral script 2	2
Combat script 2	2
Baseline 5	5
Debriefing	

presence of PTSD and a wide range of Axis I and Axis II disorders. In addition to this diagnostic instrument, all subjects completed the War Stress Inventory I and II, developed by Rosenheck and Fontana (1989) to assess broad-spectrum psychological and social problems in VA patients. Self-report scales included in the assessment battery were the Mississippi Scale for Combat-Related PTSD (Keane et al., 1988a), the Combat Exposure Scale (Keane et al. 1989b), and the MMPI-2 and the Keane PTSD scale contained within it (Keane et al. 1984).

Psychophysiological Assessment Procedure

Table 3.2 summarizes the psychophysiologic assessment procedure for each subject in the study. It combines exposure to a neutral stressor consisting of a mental arithmetic task (serial 7s), exposure to neutral slides (i.e., snow-covered mountains) and an accompanying sound track of classical music, combat stressor slides and sounds (i.e., a military unit landing in a heavy combat area in Vietnam), and the script-driven imagery that compared neutral (i.e., relaxing in a favored area) and combat (i.e., the most dis-tressing event from their Vietnam experience) scripts developed for each person individually (see Lang, 1977; Pitman et al., 1987). Measures obtained during the course of the assessment procedure were heart rate, systolic and diastolic blood pressure, EMG, and skin conductance.

RESULTS

Analytic Plan

We divided the subjects into a training sample and a cross-validation sample representing approximately 60% and 40% of the total sample, respectively. Data presented here are from the analyses completed to date and are taken from the training sample only. Keane et al. (1988b) present a more thorough description of the data-analytic approach planned for use in the study, including the methods employed in data reduction for the psychophysiological measures.

Figure 3.1 presents the mean heart rate in beats per minute (bpm) for these subjects ($n = 672$) during baseline and experimental test conditions. In general, PTSD veterans demonstrated greater heart rate at baseline when compared to no-PTSD veterans. Differential elevations were also observed for the mental arithmetic condition, the combat slide condition, and the combat script condition on this measure. Comparisons of mean heart rate in response to the combat versus neutral conditions also revealed a statistically significant difference for the combat slides (PTSD mean = 2.1 bpm; no-PTSD mean = 0.5 bpm) and the combat scripts (PTSD mean = 2.9 bpm; no-PTSD mean = 1.9 bpm).

Figure 3.2 presents the mean skin conductance data for both conditions. In comparisons of the combat with the neutral conditions, the PTSD group exhibited a greater increase in skin conductance (mean = 0.75 mS) compared to the no-PTSD group (mean = 0.33 mS). Similarly, the PTSD subjects demonstrated greater change in skin conductance as a function of the combat scripts when compared with the neutral scripts. Subjects with PTSD exhibited a mean change of 0.73 mS, while those in the
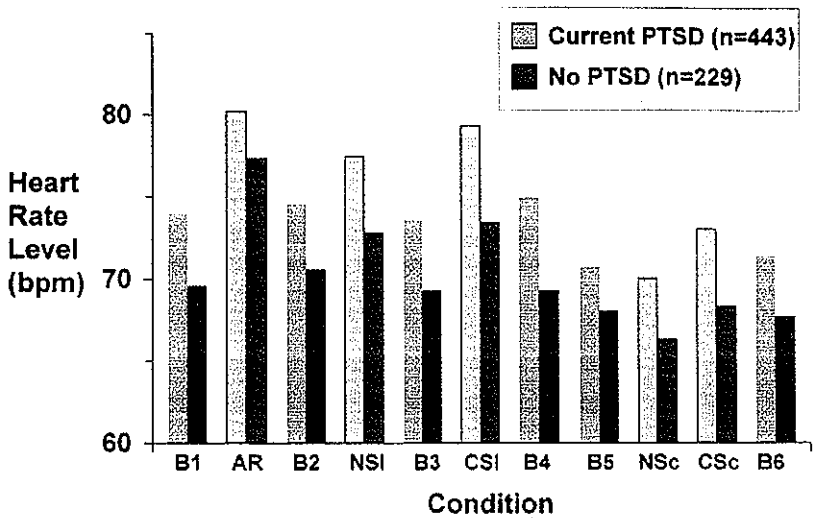
Figure 3.1. Mean heart rate levels at various baseline and test conditions. (Conditions: B1, baseline 1; AR, mental arithmetic; B2, baseline 2; NSl, neutral slides; B3, baseline 3; CSl, combat slides; B4, baseline 4; B5, baseline 5; NSc, neutral script; CSc, combat script; B6, baseline 6.)

no-PTSD group exhibited a mean change of 0.44 mS.

Lateral frontalis EMG data provided similar effects for the PTSD and no-PTSD subjects. Figure 3.3 presents the data across the experimental protocol for EMG. Statistically significant differences were observed in the means of combat minus neutral change scores on this variable as well. For the combat slides minus the neutral slides, the mean differences were 0.92 mV for the PTSD group and 0.28 mV for the no-PTSD group. For the scripts a similar pattern emerged. The PTSD group's mean difference was 1.20 mV, while the no-PTSD group's mean difference was 0.42 mV. Comparable findings were obtained for the systolic and diastolic blood pressure recordings.
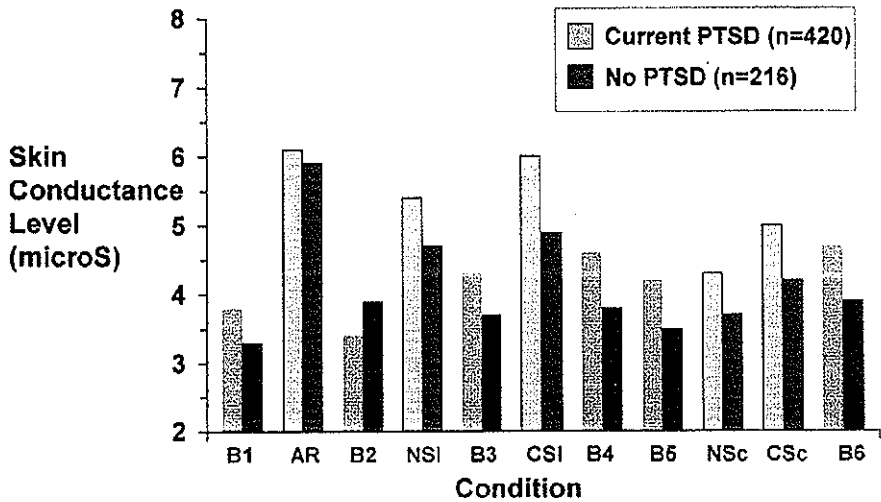

Figure 3.2. Mean skin conductance levels at various baseline and test conditions. (For explanation of conditions, see Figure 3.1.)
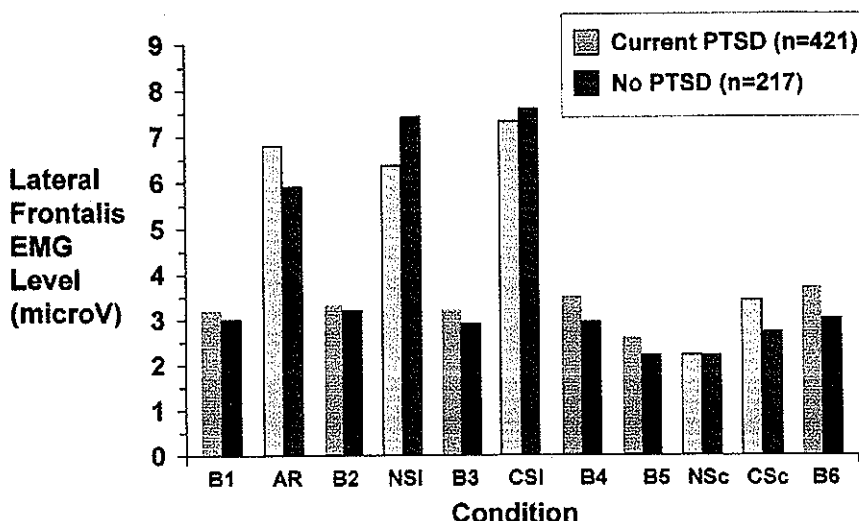
Figure 3.3. Mean lateral frontalis EMG levels at various baseline and test conditions. (For explanation of conditions, see Figure 3.1.)

We submitted all data from the psychophysiological protocol (reduced into change scores) to a logistic regression procedure to determine accuracy of classification by diagnostic grouping. Using the mean differences from neutral to combat stimulus presentation for each of the measures (heart rate, skin conductance, EMG, systolic and diastolic blood pressure, and subjective units of distress), the procedure correctly classified 65% of the subjects in the training sample.

DISCUSSION

Preliminary findings from the PIVVET study indicate that, for a substantial number of combat veterans with PTSD, there remain measurable increments in psychophysiological reactivity to cues of combat experiences some 20 or more years following the life experiences. The analyses conducted to date indicate that this reactivity may be a useful adjunct to more traditional approaches to assessment, such as the clinical interview and psychometric tests. Estimates of diagnostic accuracy in the cross-validation sample will contribute further to our understanding of the reliability of these findings of psychophysiological reactivity.

Psychophysiological reactivity in PTSD is also being replicated across populations. Orr et al. (1993) found similar elevations across measures in both World War II and Korean veterans with PTSD. Shalev et al. (1993) found that a group of male and female Israeli citizens traumatized by a variety of noncombat life experiences also exhibited this reactivity. Moreover, Blanchard et al. (1994) found evidence for psychophysiological reactivity in PTSD resulting from motor vehicle accidents.

Thus the findings of psychophysiological reactivity to cues of the original trauma appear to occur in different wars, cultures, genders, and types of traumas. Possibly most important from an understanding of the etiology of this disorder is the finding that the reactivity is most clearly observed in response to the cues that are relevant to the traumatic events themselves. Other stressful cues, sounds, or stimuli do not appear to evoke the same level of physiological reactivity as do the cues of the traumatic events.

These findings also raise other questions of central importance in our growing understanding of this disorder. Specifically, future studies are now needed to address the underlying biological mechanisms that are responsible for the development and the

maintenance of this reactivity. Delineation of these factors might spur the recognition and implementation of effective treatment interventions. A related question is whether successful treatment of this physiological reactivity through behavioral or psychopharmacological methods would yield an improved clinical outcome in terms of symptomatology and psychosocial functioning.

Left unanswered in this study is the extent to which the observed autonomic elevations are a function of a predisposition to develop PTSD or a consequence of the disorder. Future studies of the genetic predisposition to developing PTSD will shed light on this issue. Either interpretation is consistent with the findings of this study. Clearly a person-by-event interaction offers the most appealing interpretation of the findings, with personal characteristics encompassing genetic, physiological, and psychological factors.

The findings also replicate previous studies demonstrating hyperreactivity in PTSD and support the inclusion of arousal reduction methods in the treatment of PTSD (Keane et al., 1989a). Techniques that involve the repeated presentation of trauma-related cues in careful and systematic ways (i.e., the exposure therapies) would seem to be particularly warranted. Given the clinical complexity of PTSD cases, it is likely that the most effective interventions will be multiphasic in nature and will require numerous interventions in addition to exposure therapy. This would be especially true for chronic cases of PTSD with high rates of co-morbid psychological problems such as those seen in combat-related PTSD.

At least as tragic is the apparent effects of the war on PTSD veterans' spouses and children, both of whom seem to have more problems of a clinically significant nature than the families of survivors who did not develop PTSD.

The PIVVET study provided important information on the physiological representation of PTSD and the stimulus characteristics that seem to elicit pathological elevations in heart rate, blood pressure, muscle tension, and skin conductance. It is clear from these data that parameters of reactivity constitute a significant part of the PTSD clinical picture and that, even in laboratory based protocols, cues reminiscent of traumatic life experiences are able to evoke measurable physiological reactions.

Taken collectively, these studies provide important new information on the role of life stressors in inducing psychopathology. Even controlling for a host of pre-existing and demographic variables, the NVVRS demonstrated that war-zone stress exposure was strongly associated with the ultimate development of PTSD. The PIVVET study indicated that psychophysiological reactivity to cues of the traumatic events identified PTSD veterans seeking services while not identifying those combat veterans without PTSD. Although it is always difficult to draw inferences about causal agents in the absence of experimental paradigms, these studies add further support to our understanding of the relationship between exposure to war and the subsequent development of serious problems in long-term psychological and social adjustment.

CONCLUSION

The NVVRS and the PIVVET study are two of the largest studies conducted to date on the effects of war. Both studies provide information on the adverse long-term effects of exposure to life threat and terror. The NVVRS findings indicate that psychological and social problems plague veterans of war for at least 20 years following participation.

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